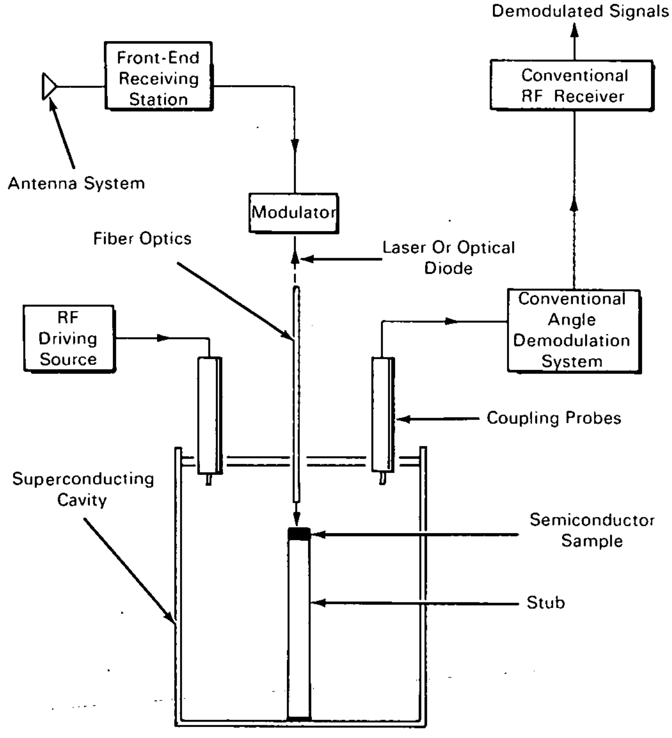
NASA TECH BRIEF

RF Noise Suppression Using the Photodielectric Effect in Semiconductors



Noise Suppression Receiving System

A technique using the photodielectric effect of a semiconductor in a high-Q superconductive cavity has been developed which gives an initial improvement of 2–4 db in the signal-to-noise enhancement of conventional RF communication systems. This technique may readily be applied in conjunction with existing ground receiving station equipment and is of considerable interest to those involved in advanced communications systems.

The capabilities of spacecraft-to-ground communication systems are limited by the relatively low transmitter powers available and by the vast distances over which the signals travel. To increase the detection capabilities of the receiving station, large antennas (85-foot or 210-foot parabolic antennas) and complex low-noise receiving systems (traveling-wave masers) are required.

A system has been conceived in which a wide-band signal plus noise can be transmitted through a narrow-band cavity due to parametric perturbation of the cavity frequency or phase. The tunable heat-frequency cavity acts as a narrow-band tracking filter and sup-

(continued overleaf)

presses noise outside of its bandpass. Initial test results show a 2–4 db improvement in output signal-to-noise enhancement, with further improvement possible through the use of higher Q cavities and a more optimum selection of semiconductor specimens.

The rf signal, received through the antenna system and mixed down to a suitable i-f frequency, modulates an optical diode. Background (thermal) noise in the form of a white gaussian process is present throughout the entire signal bandwidth. The emitted light from the diode is directed via a fiber optic bundle to a high purity semiconductor which terminates a $\lambda/4$ stub in a resonant cavity. The cavity's surface is made superconducting to ensure a high cavity Q. The modulated light beam is absorbed in the semiconductor and excess electron-hole pairs are created from the light photons. These free carriers change the real part of the complex dielectric constant of the semiconductor which in turn changes the resonant frequency of the cavity. It can be shown that the resonant frequency change is in proportion to the light induced change of the dielectric constant. Thus, the signal modulation present on the light beam is impressed upon the instantaneous cavity frequency as a perturbation. The cavity tracks the instantaneous signal modulation and rejects the thermal noise outside the passband of the cavity. Conventional electronics are then used to recover the signal.

Notes:

1. Further development of the photodielectric effect in superconductive cavities is required to determine the full potential of this technique.
2. No further documentation is available. Inquiries may be directed to:

   Technology Utilization Officer
   Manned Spacecraft Center
   Houston, Texas 77058
   Reference: B69-10225

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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(MSC-12259)